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Abstract

Elderly priming is a topic within psychology currently under intense scrutiny. Generally defined, elderly priming is the idea that priming stimuli relating to the elderly stereotype make one more likely to subsequently behave in ways consistent with this stereotype (e.g., walking slower). The current paper tests this phenomenon with the prediction that elderly stereotype priming will reduce physical grip strength, reaction times, and driving performance on a simulator task. In this study, priming stimuli were presented supraliminally with old/young faces. A marginally significant increase in peak grip strength and overall grip strength following our elderly priming manipulation was observed, compared to young or mixed faces control conditions. Additionally, participants exhibited significantly slower response time to pictures of elderly faces in the facial recognition task than in the young or mixed condition. Our hand grip results suggest the presence of an elderly priming effect, however, not the one we had originally hypothesized. I propose a model, which combines our physical resources mechanism (Klatzky & Creswell, 2014) with a motivation priming effect. This motivation prime arises, as a result of a participant's awareness of our dependent measure. Therefore, as elderly priming alters the perception of participants, causing him or her to feel relatively weak, each participant squeezes the hand grip apparatus more firmly to compensate for the perceived loss of grip strength.

Introduction

Social priming is an area of psychology whose reliability and impact is under intense scrutiny (Abbott 2013, Yong 2012). Priming effects have been demonstrated on several occasions and have been shown to affect many different behaviors. One particularly famous example of this is seen in Bargh, Chen, Burrows (1996), where experimenters presented participants with a word scrambling task embedded with elderly priming words (i.e. Florida, old, grey) and showed a significant decrease in walking speed. However, along with these findings come a series of non-replications which have called this area of psychology into question (e.g. Doyen, Klein, Pichon, & Cleerermans, 2012; Pashler, Coburn, & Harris, 2012; Shanks et al., 2013).

In this study, we test a theoretically-based approach to understanding social priming phenomena (Klatzky & Creswell, 2014). This approach involves the incorporation of environmental stimuli into a cognitive weighted bids calculator. Participants, when presented with stereotypic stimuli, experience a cognitive spreading effect to other symbolic nodes of cognition, which are in some way connected to the concept being primed. This goes on to affect a participant's energy state attribution, which then manifests in the changes in behavior or mindset observed in previous studies. In this study, we test whether one type of priming, elderly priming, affects hand grip strength, reaction time, and driving proficiency.

Priming was originally studied as the activation of nodal structures of associated ideas or concepts where the activation of one node spread to all those nodes connected to it (e.g., Dehaene et al., 2001; Meyer & Schvaneveldt, 1971;

Schacter & Buckner, 1998). This early model of priming has been recently extended to include a variety of different social phenomena. These phenomena involve both conscious and non-conscious components and can be affected by stimuli within and without our conscious attention (Bargh, 1994). One example of this new research focuses on the judgment of faces and how features of a face lead to automatic determinations of how trustworthy the face is (e.g. Todorov et al, 2009; Willis, Todorov, 2006). Another study shows that holding hot drinks makes participants more likely to act in socially warm ways (Williams & Bargh, 2008) while a third shows the effect lemon scented rooms can have on participants whose charitable activities increases when the room they wait in feels cleaner (Liljenquist, Zhong, & Galinsky, 2010). This previous work provides a foundation for priming effects across a variety of different stimuli and priming manipulations.

Aarts, Custers, & Marien (2008) propose a separate paradigm for priming effects. Participants in their study are subliminally presented with exertion primes (e.g., exert, vigorous). After completing a reaction time task, embedded with exertion priming words, participants were tested on the strength and duration of their grip. Results from this study reveal a significant increase in grip strength and duration following the presentation of exertion priming words. In addition to this classic priming manipulation, experimenters in this study add one extra condition involving the coupling of positively valenced words with their priming manipulation. The purpose of this addition was to add an aspect of reward and demonstrate how changes in motivation work in tandem with priming effects.

Results from this separate condition reveal significantly increased grip strength and duration when compared to the prime-only condition and the control condition.

Various other examples show how priming effects can be achieved using subliminal (Greenwald et al, 1998) or supraliminal stimuli (Bargh et al, 1992; Fazio et al, 1986). Further it is suggested that these priming effects will be reasonably consistent so long as a participant remain unaware of exactly what construct is being primed (Bargh, 1994). This series of work establishes a wide variety of different priming paradigms and demonstrates the applicability and flexibility of priming effects.

Perhaps the most well-known social priming studies focus on the elderly. Specifically, it has been shown that scrambled sentences containing elderly stereotypic words (elderly priming) makes participants walk slower (Bargh, Chen, Burrows, 1996). For example, in two initial studies, detailed in Bargh et al (1996), used a word scrambling task to prime participants with two separate stereotypes. The most well known involved the imbedding of elderly primes (i.e. Florida, old, grey) into randomly organized strings of words. Participants were instructed to construct coherent sentences in what, they were told, was a language related test. After completing this task, participants were told the study was over and they were allowed to leave. Without the participant's knowledge they were then timed as they walked out of the door to the study to a predefined end point. This process made up this study's primary dependent measure, the walking speed of participants. Results indicate that the imbedded elderly primes had a significant impact on reducing walking speed in participants.

A second study (Bargh, Chen & Burrows, 1996) observed the effect of words priming rudeness and politeness on the likelihood that a participant will interrupt a scripted conversation between the experimenter and a trained confederate. Experimenters used the same word scrambling test from the previous experiment to present their priming words. Results revealed a step like progression with those primed with politeness being significantly less likely to interrupt the conversation than were the control group who were significantly less likely to interrupt than were those primed with rude words.

Yet, more recent efforts to replicate these findings have met with mixed results. One study (Doyen, Klein, Pichon, & Cleerermans, 2012) sought to exactly replicate the methods from Bargh, Chen, & Burrows (1996) in an elderly priming study. Instead of a confederate, a laser timing system was used to measure walking speed as participants left the study room. Results from this study revealed no significant results and, following its' publication, the concept of elderly priming and all previous work in social priming came under intense scrutiny (Bartlett, 2013). The controversy surrounding elderly priming is summed up in a series of non replications (e.g. Doyen, Klein, Pichon, & Cleerermans, 2012; Pashler, Coburn, & Harris, 2012; Shanks et al., 2013). This group of researchers, among others, challenged the concept of elderly priming and suggested Bargh's results were due to poor experimental methods. However, if this is the case, why then do we see various successful replications using the same types of primes (Chambon, 2009; Cesario et al, 2006)?

In answer to this question, we posit an intersensory interaction theoretical account to help explain when social priming effects are likely to occur. Specifically, Klatzky & Creswell (2014) describes this intersensory interaction as being an integration of a variety of "weighted bids" which is similar to the process of estimating the weight of a cup sitting on a table. When a participant is asked to judge this weight, several different sensory tools are at their disposal. First, they might receive visual input and might realize that a bottle made of plastic might weigh less than one made of metal. Next they might squeeze or pick up the cup to gain an appreciation for the cup's density and other dimensions. Each of these different types of information receive a different "bid" and some "bids" carry more weight than others. All of this information, along with their weights, are then integrated and eventually calculate the estimation of that objects weight which a participant may then report.

Elderly priming might work in a very similar way. The distinction between elderly priming and the cup example is seen in the "weighing" process inherent in this model. In elderly priming "weight" is attributed not to a series of sensory information, as in the cup example, but to patterns of activation of associated memories and heuristics which color each person's unique view of the elderly stereotype. This activation is thought to originate through the presentation of a related environmental stimulus, such as an elderly stereotypic word in a sentence unscrambling priming task.

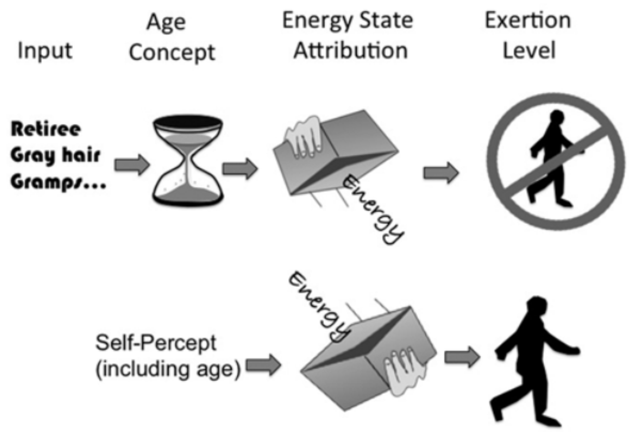

Figure 1: Energy state bids are activated by elderly priming words. This activation goes on to affect our energy state attribution, manifesting in our altered exertion level.

We test this model in an elderly priming study. The current study employs a supraliminal presentation format. We use pictures of elderly faces to activate the elderly stereotype in a task which requires participants to determine the gender of each face. Dependent measures for this study involve hand grip strength, response time to each gender determination, and a driving simulation. Grip strength was measured in three ways. These include the peak strength of the participants grip, the overall force measured with the interval of the grip strength function, and a final measure of a participants ability to reach their initial peak grip strength, measured as the slope from the beginning of the squeeze to the first recorded peak. Building on the work of Bargh and colleagues we predicted the participants in the elderly primed condition would act in ways that are consistent with this stereotype (i.e., slower to react, weaker handgrip strength, and poorer driving performance). Specifically, I hypothesize that the elderly priming condition will exhibit weaker and less responsive grip than the mixed and young conditions. I hypothesize that the elderly prime condition will exhibit decreased driving proficiency when compared to the young and mixed conditions. I hypothesize that reaction time will be significantly slower in participants who have been primed with the elderly stereotype when compared to the young and mixed condition.

Method

Participants and Design

The design of the current experiment was a within subjects one-way design with three levels of our independent variable. I recruited 34 participants, 17 males and 17 females, from the Carnegie Mellon University campus. Participants were compensated with one research credit toward introduction to psychology level courses with a research requirement. Participants were run through a one hour experiment which was presented as a series of unrelated tasks that the lab was interested in using in future studies. The sample was 44.1% Asian American, 23.5% Caucasian, 2.9% African American, 5.9% Latino/Hispanic, and 20.6% Other.

Procedure

Upon entry into the study room, participants complete informed consent and then begin a series of tasks which are broken up into three identical blocks, each corresponding with the elderly prime condition, the young prime condition, or the mixed control condition. Every participant completed each of these three blocks and the order, which they were presented was counterbalanced across study participants. Both experimenter and subject were blind to the order of conditions.

Each block consisted of three subparts. First participants completed a reaction time task where they identify the gender of pictures depicting different faces. They completed this task on a computer by pressing "1" if the picture displayed a female face and "2" if the picture was of a male face. Each condition consisted of fifty total trials and pulled pictures from three separate sets of pictures. Our primary manipulation was the age of the pictures which varied depending on which set of pictures was selected. In one condition participants were shown only elderly faces (Ages 49 and up). In a second condition, participants were shown only young faces (Ages 22 and below). In a third condition participants were presented with a random mix of both age groups. There were no repeated faces in this final condition and every condition was matched for the number of faces. Pictures were randomly selected from each list leading to equal repetition of faces in each condition. The speed with which each participant responded to each picture as well as the overall number of correct responses were recorded.

Pictures for this task were pulled from the neutral face stimuli database from the Park Aging Mind Laboratory (Minear & Park, 2004). The forty total pictures selected for this task were chosen based upon, first, the previously mentioned age requirements, then the gender and ethnicity of the person displayed in the picture. Half of the faces present in the current study are female faces and twenty percent of the faces presented are African American, the remainder being composed of Caucasian faces. Pictures are matched across condition based on gender and ethnicity. Each condition is matched for the twelve new faces presented in each of the three conditions of the study.

Following the completion of one 50-trial sequence, participants performed a grip test, using a hand dynamometer which fit into their hand much like the handle of a tennis racket. Each grip test consisted of a 2000 ms "Ready" screen followed by a 3000 ms "Squeeze " screen and finally a 1000 ms "Stop" screen. A period of calibration took place at the beginning of the study where the experimenter instructed participants to squeeze the dynamometer with similar to the force they might exert during a handshake. If force was not within 0-100 Newtons, feedback was provided. Participants were then told to mimic this grip to the best of their ability throughout the remaining hand grip trials. Within each block, the squeeze test occurred three times, once after the sequence of old faces, once after the young, and once after the mixed. The variables of interest were the total force exerted over three seconds (measured as the Integral of the curve generated by the hand grip software) and the participant's peak grip strength. Data was recorded and processed using LoggerPro software.

Finally participants were asked to complete a brief driving simulation completed on the SpeedDreams2.0 software. The simulation involved the Ruudskogen Racetrack, which participants were told to complete "as safely as possible". This final task involves three primary dependent measures, namely, the time to complete the race, the maximum speed, and a recklessness score. The final measure is calculated by the experimenter as the sum of the number of crashes and the number of times the participant goes off road throughout the duration of the race. This calculation was made by the experimenter who was blind to study condition.

Data Analysis

Handgrip data for this study was averaged across the three squeezes performed in each block. The span of a "squeeze" was defined as starting after a recorded increase in strength of greater than one Newton, and ending once the resting grip strength had again been reached. The integral was taken of each function with the constraints of the previously defined grip as limits. Peak was defined as the maximum strength achieved within the limits of the squeeze. Reaction time was recorded through eprime output. Finally driving performance was measured in multiple ways. Overall race completion time and top speed were recorded from SpeedDreams2.0 data output. The recklessness measure was recorded by a blind experimenter who counted the number of times a participant drove off road and the number of times the participant ran into a wall. These two measures were then summed creating the recklessness measure. One subject was removed from data analysis on the grounds that they were significantly weaker in the grip strength measure.

Results

All hand dynamometer data (peak grip strength and integral grip strength) showed significant positive skew in preliminary analyses and were log transformed prior to analysis. It was predicted that peak grip strength would decrease following exposure to elderly faces compared to peak strength following the mixed and young conditions. To test this hypothesis we conducted a repeated measures ANOVA with priming condition as the within-subjects independent variable consisting of three levels. We found a significant effect for priming condition, $F(1,31)= 4.02$, $p= 0.05$, $\eta^2= 0.12$. Specifically, participants who had been exposed to elderly faces ($M=$

1.68N, *SE*= 0.04N) exhibited higher peak grip strength than did the mixed condition (*M*= 1.63, *SE*= 0.05) or the young condition (*M*= 1.634, *SE*= 0.04). Follow-up pairwise comparisons reveal a significant difference between the elderly and mixed conditions (*p*= 0.03), as well as a significant effect between the elderly and young conditions (*p*= 0.05).

It was predicted that the overall force exerted in our grip strength measure, measured as the integral of the force function, would decrease for participants in the elderly condition. To test this hypothesis we conducted repeated measures ANOVA with priming condition as the within-subjects independent variable consisting of three levels. We found a marginally significant effect for priming condition, $F(1,31)= 3.973$, $p= 0.055$. Specifically, participants who had been exposed to elderly faces (*M*= 2.02, *SE*= 0.04) exhibited greater overall grip strength than did the mixed condition (*M*= 1.98, *SE*= 0.04) or the young condition (*M*= 1.97, *SE*= 0.04). Pairwise comparisons reveal a significant effect between the elderly and mixed conditions, (*p*= 0.04), as well as a marginally significant effect between the elderly and young conditions, (*p*= 0.055).

We predicted recklessness to be significantly higher following exposure to elderly primes compared to exposure to young prime or mixed prime conditions. To test this hypothesis we conducted a repeated measures ANOVA with priming condition as the within subjects independent variable consisting of three levels. Contrary to this hypothesis we did not found a significant priming effect for age, $F(1, 33)= 0.35$, $p= 0.56$, $\eta^2= 0.01$. There were no significant difference in recklessness between the elderly (*M*= 7.50, *SE*= .74), mixed (*M*= 7.56, *SE*= 0.81), and young conditions (*M*= 7.03, *SE*= 0.83).

In a secondary measure, we predicted that the presentation of elderly faces would result in significantly slower reaction times in participants in the facial priming task. To test this hypothesis we conducted a repeated measures ANOVA with prime condition as the within subjects independent variable consisting of three levels. Consistent with this hypothesis we found a significant effect for prime condition, $F(1, 29)= 4.15$, $p= 0.05$, $\eta^2= 0.12$. Specifically, participants were slower to make gender discriminations when exposed to the mixed condition (*M*= 738.10ms, *SE*= 19.80ms) and to the elderly condition (*M*= 722.602, *SE*= 25.85), while making the fastest gender discrimination judgments with young faces (*M*= 694.96ms, *SE*= 25.36ms). Pairwise comparisons reveal a significant difference between the elderly condition and the young condition, ($p= 0.05$), as well as a significant difference between the mixed and young conditions, ($p= 0.006$).

Discussion

The study results are not consistent with our original hypotheses that the supraliminal presentation of elderly primes would reduce grip strength, slow response time, and decrease driving proficiency. Results from our measures of overall grip strength and peak grip strength indicate significant differences in the elderly condition when compared to the young and mixed conditions. Pairwise comparisons indicate significantly increased overall and peak grip strength in the elderly condition when compared with the mixed and young conditions.

At first glance, these results support the idea that elderly priming has an effect on grip strength. However, this elderly prime manipulation appears to, contrary to our original hypotheses, provide more physical resources to participants. Hull et al (2002) proposes the power of priming arises as a result of the self relevance of the priming stimuli. This integration of sensory stimuli, they argue, may then have a significant effect on our perceptions. Through these changes in perception, words such as old, sickly or grey are thought to alter our behavior. Hull et al (2002) also makes an important point regarding one requirement for priming effects to work. Within his model of priming, supported by other researchers (Bargh et al, 2012), it is vital for the priming manipulation to not reveal its' nature to the participant. Therefore, whether using subliminal or supraliminal primes, it is important for the priming manipulation of a given study to remain unknown to the participant.

This sense of awareness is the distinguishing characteristic of the current study and is a factor that separates it from previous work in priming (Bargh et al, 1996). This difference could be behind the counterintuitive findings seen in the current study. Participants in Bargh et al (1996), complete the word scrambling task and believe their performance on that task is the sole measurement of the study. The true dependent measure of the study (walking speed) is only revealed to them once they believe they have completed the study and are on their way out of the building. The surreptitious nature of this dependent measure is fundamentally different from the hand grip measure in this study as participants are aware they are being tested. It is possible that this awareness is leading to a sort of subconscious compensation effect following the presentation of the face primes.

Evidence can be seen for this compensation mechanism in literature pertaining to the cognitive impairment associated with alcohol impairment. Within this work, work has been done which shows the impact environment and context can have on the motor deficits associated with alcohol consumption (Vogel-Sprott, 1992). Furthermore, when this environmental stimulus involves monetary reward, experimenters see a drastic reduction in the impairments following the consumption of alcohol (Vogel-Sprott & Sdao-Jarvie, 1989). It is generally agreed upon that this tolerance for alcohol results from an adaptive, compensatory reaction that works against the drugs' effect. These, drug-compensatory effects have been theoretically linked to an expected rewarding outcome following non-alcoholic performance (Vogel-Sprott & Sdao-Jarvie, 1989). Within the current study, it is possible we are witnessing a similar effect, with a reward consisting of experimenter approval for good performance on study tasks.

Klatzky & Creswell (2014) propose that a weighted bids model is at work in the elderly priming phenomenon. Within this model, several incoming signals are coded, weighted, and then summed as we create the corresponding perceptual experience. The cup example used in the introduction involved largely tactile sensation as we made an estimation of how heavy the cup might be. Characteristics of the cup under consideration included how dense the object felt, what material the bottle appeared to be made of, and also how much force needed to be exerted when picking up the cup. It is possible that these processes were similarly at play in elderly priming with elderly priming words activating our concept of the elderly, which then interplays with our self concept eventually manifesting in the altered behavior seen in previous elderly priming studies. It is possible that there is an added element to this model linked to participant awareness of being tested and the compensation effect discussed previously. For example, the introduction of an elderly priming stimulus, if effective, might create a semi conscious perception of a reduced perception of available physical resources. This alteration might then be brought to conscious awareness at the beginning of the grip tests as participants become aware of, what seems to be, reduced strength in their hand. This realization might then cause them to over compensate by squeezing significantly harder as they attempt to make up for the apparent reduction in their physical resources.

One study tested the affect of explicit achievement motivation on motivation priming and found a significant effect for their achievement manipulation (Engeser & Baumann, 2014). Similar to the physical resources mechanism proposed the current study, Engeser & Baumann attribute their significant increase in explicit achievement motivation as being activated by the introduction of self-relevant achievement priming stimuli.

This physical resources compensatory account is also consistent with results from Aarts, Cluster & Marien (2008). Results of this study revealed increased grip strength upon the subliminal presentation of exertion primes and then further increase in grip strength when exertion primes were paired with a rewarding stimulus. Experimenters in this study suggest these results are due to an increase in motivation, linked to the coupling of the priming effect and a reward based increase in motivation. This increase in motivation complements the nature of their exertion primes, further increasing grip strength. Within these results, lies the same motivation based increase in performance at the root of the proposed model for the current study. This synchronous activity of exertion and achievement primes is an area of distinction when comparing results to the current study. Whereas the primes in Aarts et al (2008) work together to increase effect size, our elderly prime works against the participant's motivation to provide good data. This opposition manifests in the small and reversed effect sizes demonstrated in this study.

In addition to the significant handgrip findings of this study, we report significant slower response time in the gender recognition task for elderly (and mixed faces). In the beginning of the study we hypothesized this effect would occur (namely, when one is primed with an elderly face, it slows their corresponding movements, such as reaction time), however, there are several possible explanations. First it is possible that our young adult participants were better able to identify gender in those faces, which were similar to their own age. This familiarity effect would likely manifest similarly to the results seen in this study. Second, elderly faces might be less distinctive than young faces, resulting in slower reaction times. For example, facial hair was less prevalent in the elderly pictures and it is possible that the hairstyles seen in the elderly pictures are more gender neutral than in the case of the conditions including younger faces. Finally, this effect, consistent with our original hypothesis, may be due to an elderly priming effect. This measure of reaction time is the closest measure we have temporally to the actual presentation of the elderly primes. These results may therefore reflect the immediate incorporation of the age concept into our proposed physical resources model of elderly priming. Additionally, there is some question as to why the mixed group responded more slowly than the elderly group. One explanation could be that the cognitive mechanism behind gender discrimination could be somewhat age dependent. If this were the case, then the switching back and forth between a young and old concept could be causing the reduced reaction time.

The questions explored in the priming literature extend to envelop our understanding of our own self-concept and, further, the concept of free will. What aspects of our environment and our character form how we think, feel, and behave? This study emphasizes the importance of awareness in the governing how we think about these types of questions. Although this study suggests our thoughts and behaviors can be controlled by environmental stimuli presented outside conscious awareness, it also supports a model built on self-control, governed by our ability to attend to and critically consider those preconceptions and attitudes, which become active with priming manipulations.

Future work in this area might explore the effect of motivation and reward on the various types of priming manipulations. Discovering the limitations and extensions of this physical resources mechanism will be important in improving our understanding of priming effects. Additional work might also focus on the differences between dependent measures requiring participant attention and those performed without the participants' awareness (e.g., walking speed). This type of research could provide a clearer picture of social priming effects and our present results.

	Elderly Peak Grip Strength	Mixed Peak Grip Strength	Young Peak Grip Strength	Elderly Overall Grip Strength (Integral)	Mixed Overall Grip Strength (Integral)	Young Overall Grip Strength (Inegral)
Mean Value	115.37	109.85	104.29	53.33	50.76	49.75
Standard Deviation	55.11	60.37	53.77	25.36	29.36	29.13
Log_{10}(Mean)	1.68	1.63	1.63	2.02	1.98	1.96

Table 1: Mean, standard deviation, and log transformed values for relevant hand grip measures.

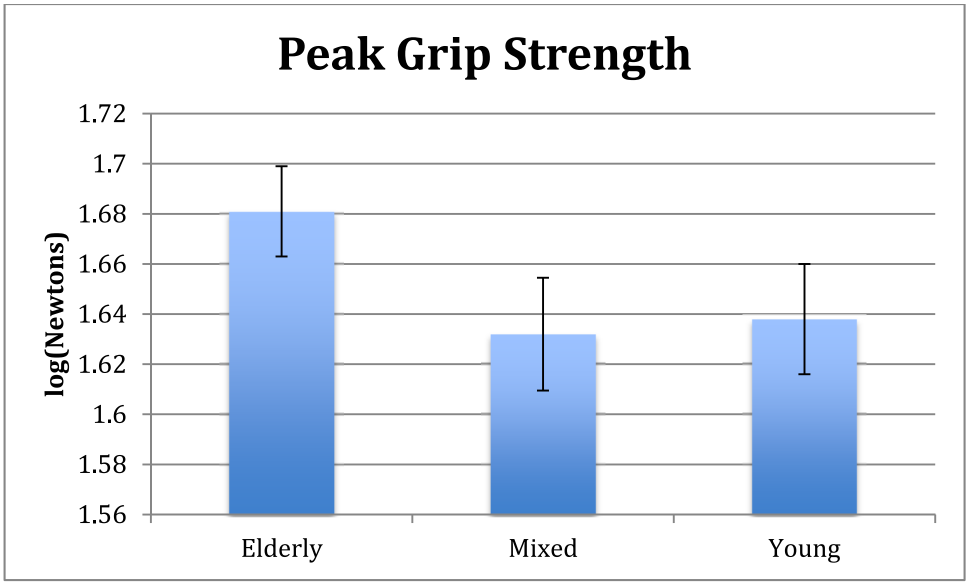

Figure 2: Log transformed peak grip strength measured as the average peak strength of three grip tests in each of three conditions.

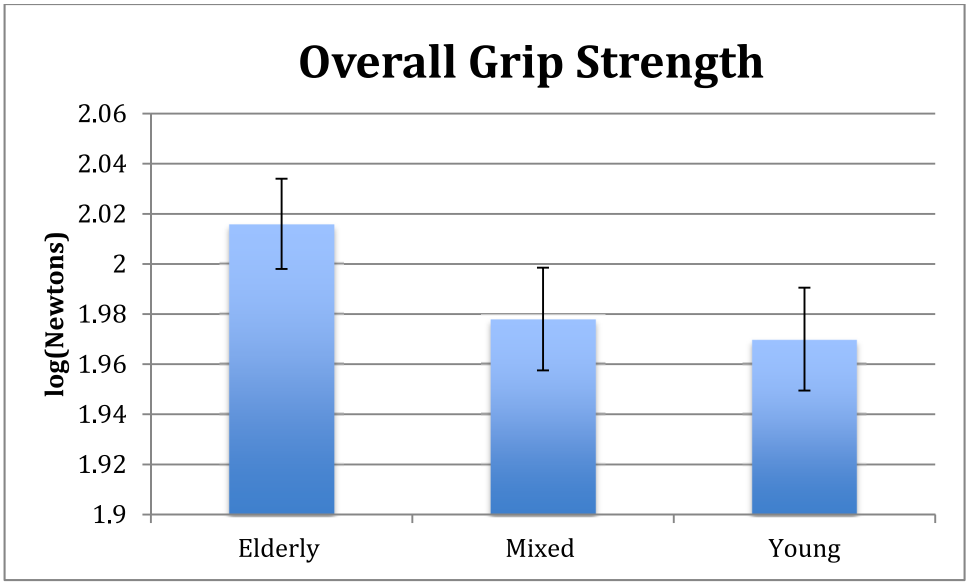

Figure 3: Log transformed overall grip strength measured as the average integral of three grip tests in each of three conditions.

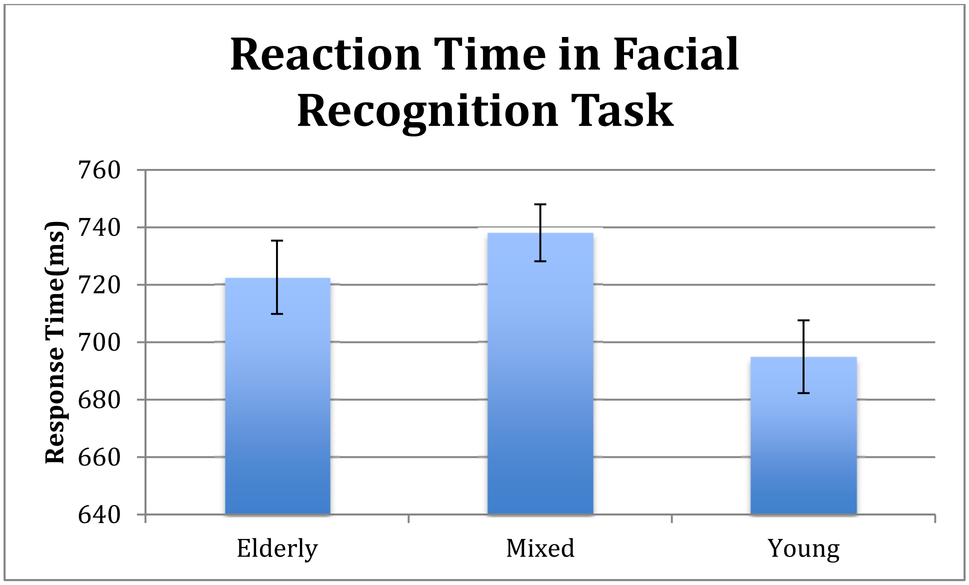

Figure 4: Reaction time in the facial recognition task averaged across fifty trials.

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